Space Weather Technical Forecast

Issued on Tuesday, 16 August 2022 at 01:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Ongoing Active electron flux and fluence. G1/Minor storm likely from day 2 (17th). Further Moderate flares (R1-R2 Radio blackouts) likely throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity is Moderate, with frequent C-class flares and in recent hours a number of low level and mostly impulsive M-class flares have been observed. The largest of these was a M2.7 which peaked at 15/1654 UTC and originated from the most active region on the visible disc AR3078 (Dkc/Beta-Gamma-Delta) in the southwest quadrant. This event produced an Earth directed CME that is due to arrive on day 2 (17th) at the same time as an earlier CME that left the sun on 14 Aug, as mentioned below. AR3081 (Dai/Beta-Gamma) is relatively large and exhibits some magnetic complexity, but has remained stable during this period. AR3079 (Dai/Beta-Gamma) in the southwest released an impulsive M-class flare at 15/1735 UTC. Another region of note is AR3076 (Cro/Beta-gamma) in the northwest. This was responsible for the long duration C flare that started at 14/1200 UTC and emitted a CME towards Earth, with an expected impact on the 17th. Another CME occurred from a filament eruption in the southwest quadrant at around 15/0500 UTC. The fifth numbered region on the disc is AR3074 (Hsx/Alpha) in the southwest quadrant, and it remains small and stable. A couple of small and possibly transitory sunspots are also on the visible disc as unipolar Axx/Alpha.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, is showing a slightly elevated wind environment, around 450m/s with a slowly declining trend. Density remained at average levels with a slowly declining trend (5-8nT). The IMF was weak throughout with the north-south component varying weakly (+/- 4nT). The phi angle was positive (away from the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV), as measured by GOES16, was at Background levels. The high energy electron flux (greater than 2 MeV) was High, with a peak of 7.58e3 pfu at 15/1550 UTC. The 24-hour integrated electron fluence was above Active threshold throughout, with a rising trend and an observed value of 2.78e8 integrated pfu at 16/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is forecast to be moderate and currently there is a chance (15%) for activity to become High if there are any significant M-class flares or X-class flares over the coming days. The most likely source region for these would be from the developing sunspot region AR3078 which is near centre disc in the southern hemisphere.

Solar Wind / Geomagnetic Activity: Solar winds are expected to decline closer to slow-ambient levels over the next 24 hours. On day 2 (17th), Earth is expected to connect with the high speed stream from coronal hole 14. This enhancement is likely to be further enhanced by at least one CME arrival, and forecast to impact Earth around the same time frame. Geomagnetic

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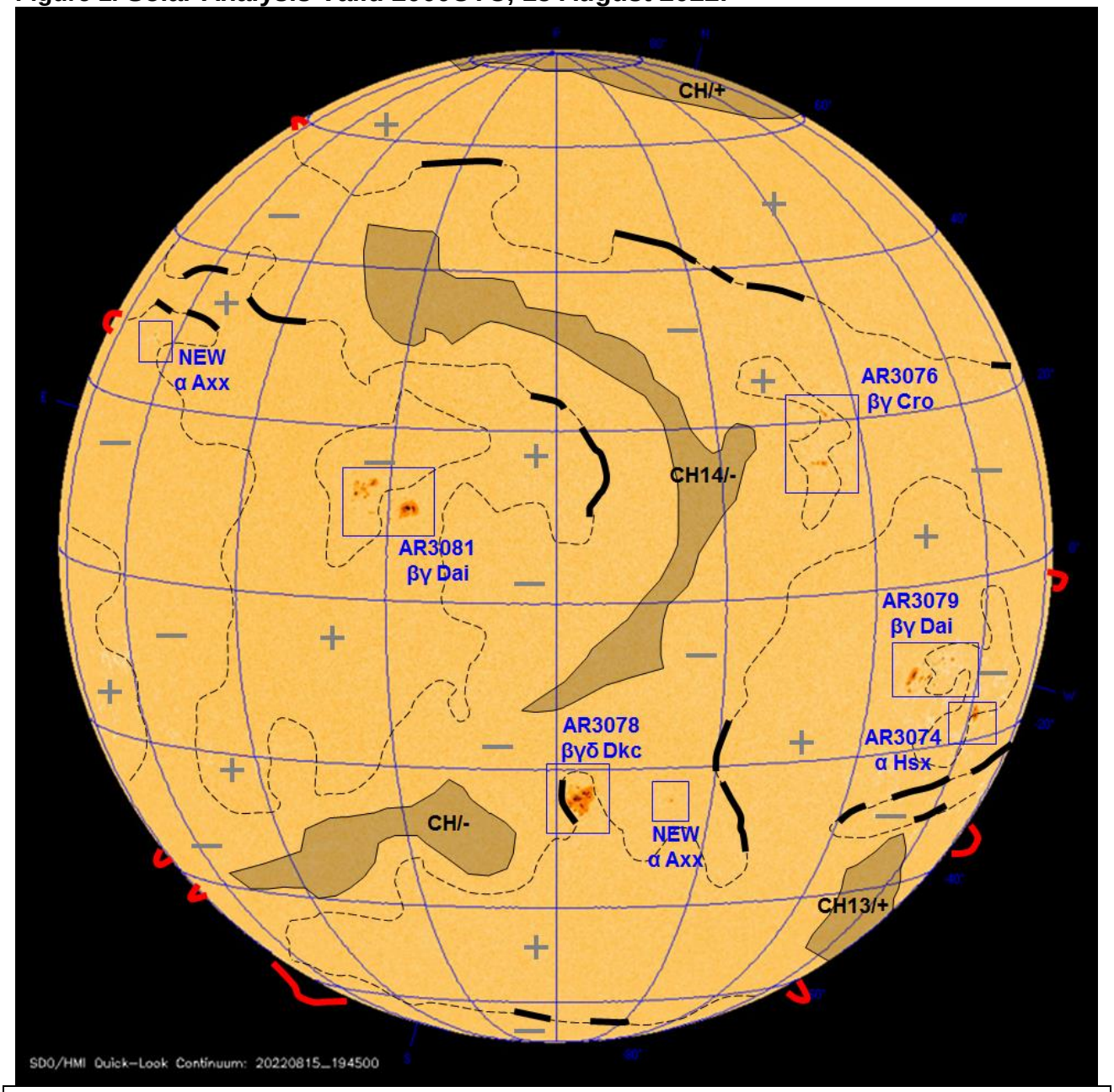
activity is expected to be Quiet, with isolated Unsettled intervals over the next 24 hours. From day 2 (17th), activity is expected to become Unsettled to Active, and G1/Minor Storm intervals likely. There is also a chance of a G2/Moderate Storm in association with the CME arrivals.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is likely to remain at background levels, although with a slight chance of an S1 or greater event. High energy electron flux is expected to continue at a moderate to High (1e3 pfu) levels through day 1 (16th) before becoming suppressed during the course of day's 2 and 3 (17th and 18th). Electron fluence values are forecast to remain above the Active threshold during day 1 (16th), bur during day 2 (17th) fluence values are expected to drop below the Active threshold and will probably remain below for the rest of the period.

Figure 1. Solar Analysis Valid 2000UTC, 15 August 2022.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

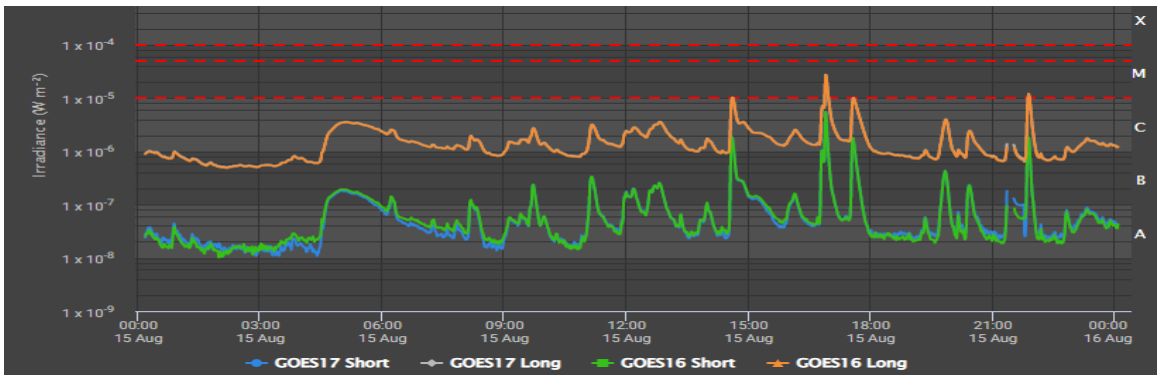
Solar winds are expected to be decline to become close to slow-ambient levels on day 1 (16th). On day 2 (17th) Earth is expected to connect with the high speed stream from coronal hole 14, as it moves into a geoeffective position. This coronal hole is a recurrent feature and solar winds are indicated by persistence to reach similar levels that occurred during the previous rotation, becoming elevated at around 500-600km/s. This enhancement is likely to be further enhanced by the arrival of a CME, which is forecast to impact Earth around the same time frame. Along with this there is a chance of further enhancement due to embedded CME effects, from other CMEs which left the Sun over the past couple of days.
Geomagnetic activity is expected to be Quiet, with isolated Unsettled intervals over the next 24 hours. From day 2 (17th), activity is expected to become Unsettled to Active, and G1/Minor Storm intervals are likely to occur. There is also a chance of a G2/Moderate Storm, most likely when the CME(s) mentioned above impact Earth.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	60	40	20
Strong	G3	No	1	20	10	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
14/1747	Partial Halo	AR3076	NW quadrant	620	17/0600 UTC	Drawn out C-class flare that was accompanied by Type II emission

Figure 2: GOES X-ray flux plot showing recent M-class flares on 15 August.



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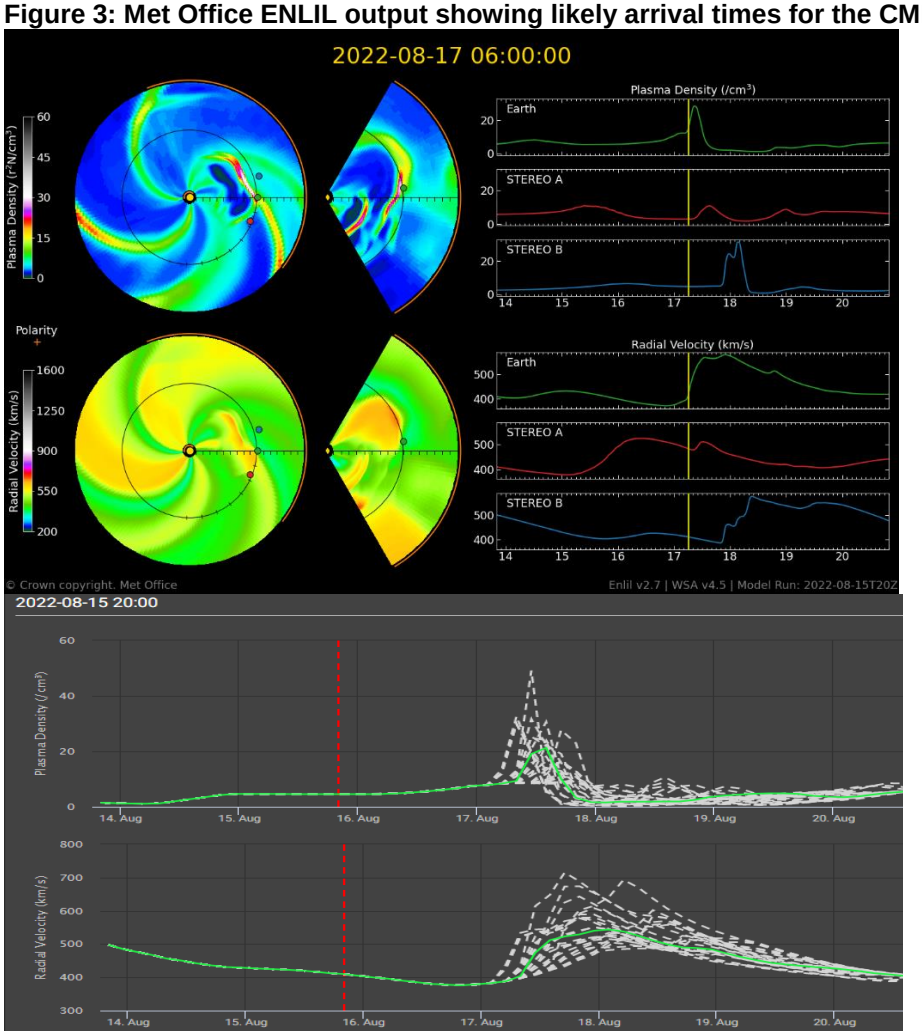
Radio Blackouts - X-Ray Flares:
Solar activity is forecast to be moderate and currently there is a chance (15%) for activity to become High if there are any significant M-class flares or X-class flares over the coming days. The most likely source region for these would be from the developing sunspot region AR3078 which is near centre disc in the southern hemisphere. There are also other candidates for flaring that need to be considered given their size and magnetic distribution, namely AR3081 (Dai/Beta-Gamma) in the northeast and AR3079 (Dai/Beta-Gamma) in the southwest. As well as this there are several relatively large filaments which are on the current disc.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	70	70	60
Very Active	R3 to R5 X Class	No	15	20	20	15

Figure 3: Met Office ENLIL output showing likely arrival times for the CMEs on 17 August.



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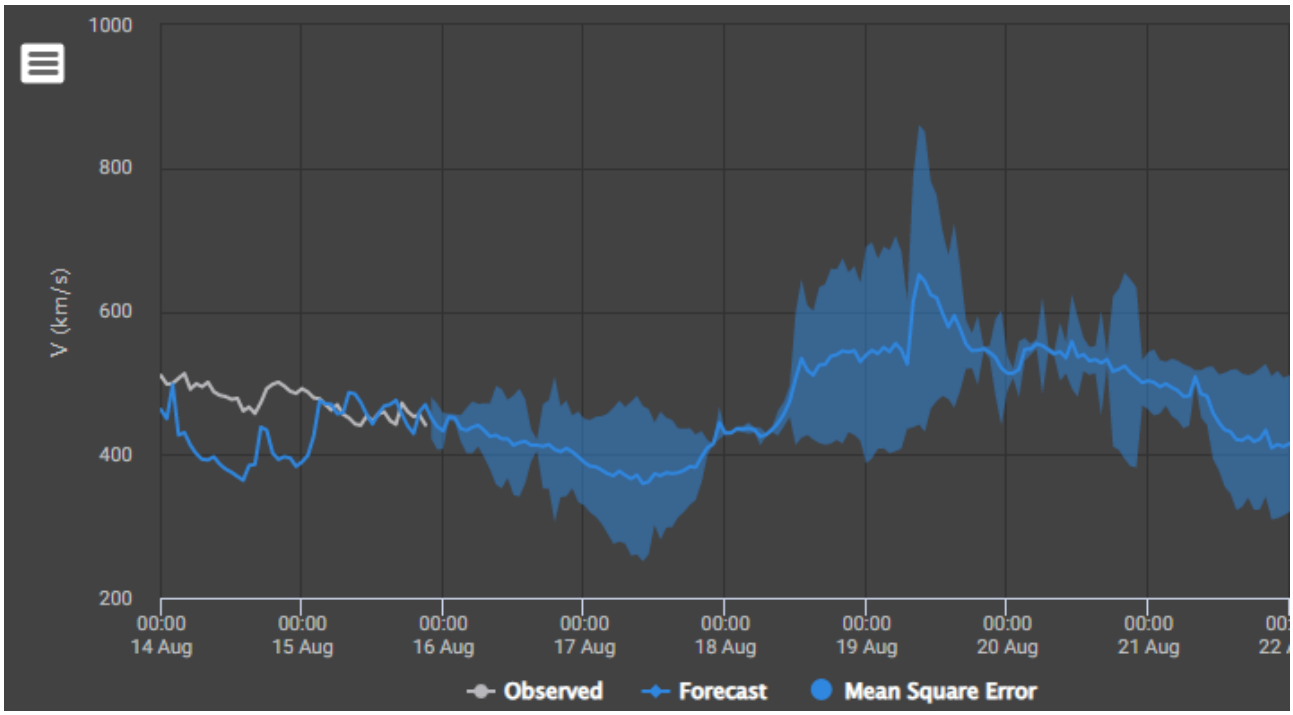
Solar Radiation Storms - (High Energy Protons):
The high energy proton flux (greater than 10 MeV) is currently at Background levels, and is likely to remain at this level through the period. AR3078, AR3079 and AR3081 all carry a non-zero, very slight risk of proton events and as they transit further westwards, the risk increases slightly through the period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	15	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: Met Office SWPM output showing HSS arriving on 18 Aug, probably 24hrs too delayed.



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High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) will probably remain at mostly high levels during the next 24 hours. On day 2 (17th), electrons are expected to become suppressed due to the expected increase in geomagnetic activity associated with the arrival of the coronal hole enhancement and the CME(s). A rise towards the High threshold is likely once again later on day 3 and into day 4 (18th and 9th) as geomagnetic activity begins to subside.
Electron fluence values are expected to remain above the Active threshold through day 1 and into day 2 (17th and 18th), with REFMs guidance thought to be slightly too low. During day 2 and into day 3 (17th and 18th) fluence values are likely to drop below the Active threshold although in the table above elevated probabilities have been maintained to indicate the possibility for fluence levels to remain above the active threshold.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	Yes	100	90	50	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: High energy electron flux and Met Office REFM output.

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